

## HIGH-DENSITY INFRARED SURFACE TREATMENTS OF REFRACTORIES

### BENEFITS

The benefits of high-density infrared (HDI) processing of refractories include

- ➔ Reduced surface porosity (by essentially sealing the surface to prevent liquid penetration).
- ➔ Changed surface chemistry by either diffusing desired species into the surface or bonding of an adherent coating onto the underlying refractory (that would inhibit wetting and/or corrosion).
- ➔ Improved mechanical properties.

### APPLICATIONS

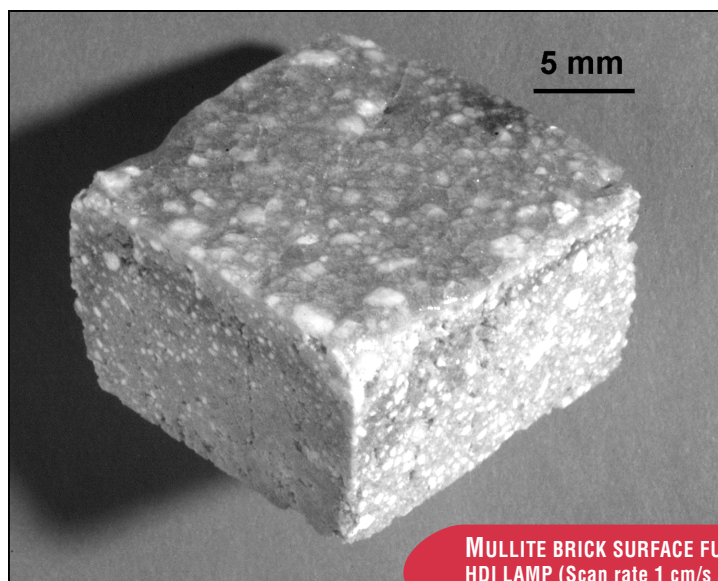
Ceramic refractories are widely found in high-temperature, chemically demanding applications. These materials are critical construction materials for energy-intensive industries. Examples where refractories are key materials include glass furnaces, metals refining and casting, pulp and paper processing, boilers for power generation, and chemical and petrochemical processing. Thus, refractory materials are truly a cross-cutting technology for the Industries of the Future (IOF) including

- ➔ Agriculture,
- ➔ Aluminum,
- ➔ Chemical,
- ➔ Forest Products,
- ➔ Glass,
- ➔ Metalcasting,
- ➔ Mining,
- ➔ Petroleum, and
- ➔ Steel.



## INNOVATIVE SURFACE PROCESSING WILL REDUCE THE PENETRATION, WETTING, AND REACTION BEHAVIOR OF REFRACTORIES.

Refractory materials have remained largely unchanged for many years, and industrial users need fundamentally new refractory systems because many current materials are reaching their ultimate performance limits. Areas where economically viable breakthroughs are needed are in corrosion/erosion resistance, improved mechanical properties, and the ability to act as a host or support for high-emissivity coatings and advanced catalysts. One of the major mechanisms for the degradation of refractories and a general decrease in their performance has been penetration and corrosion by molten materials such as metals, glass, molten salts, and high-reactivity gases. As a method to greatly improving performance, this project will use high-density infrared (HDI) heating to surface-treat refractories. The HDI processing facility at ORNL utilizes a unique technology to produce extremely high power densities of  $3.5 \text{ kW/cm}^2$  with a single lamp. HDI is capable of heating the near-surface region of materials to very high temperatures, where sintering, diffusion, and melting can occur. The HDI treatment of refractories would reduce surface porosity, allow surface chemistry changes to be performed, and improve mechanical properties.



MULLITE BRICK SURFACE FUSED BY THE USE OF THE  
HDI LAMP (Scan rate 1 cm/s at a radiant power of  
 $800 \text{ watts/cm}^2$ )

## Project Description

**Goal:** The goal of the project is to make a major advancement in improving the behavior of refractory materials used in industrial processes. Refractories play an integral part in the operations of numerous industries of the future, and advancements can have a significant and large impact on the viability of those industries. These improvements will be realized through surface modifications with HDI.

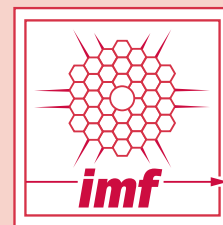
**Issue:** Surface modification of refractories using high-intensity heating techniques is a relatively unexplored area where there is little past experience. Consequently, there is a need to establish processing-microstructure-property relationships for the various types of refractories of interest. These relationships will then be correlated with performance behavior in both simulated and actual test conditions.

**Approach:** The project will be performed as a series of tasks. The objectives of the three tasks are (1) demonstrate the ability to reduce open surface porosity on commercially available refractories and evaluate the corrosion behavior, (2) fabricate corrosion-resistant surface layers on refractories by either diffusion coating or selective sintering of secondary layers, and (3) produce refractories having high-emissivity surface coatings (in addition to low porosity and high corrosion resistance).

**Potential Payoff:** Surface modification of refractories by high-density infrared treatments has the potential to reduce the penetration, wetting, and reaction behavior between refractories and the process environment (be it molten glass or metal). The result is more robust refractories. By reducing the interactions during exposure, these treatments have the potential to significantly extend the lifetime of refractory materials. Such a benefit would result in improved productivity, increased energy efficiency, less downtime, and a reduction of waste products.

## Progress and Milestones

- ➔ Demonstrate surface porosity reduction on oxide-based refractories and show improved corrosion resistance in simulated process environments.
- ➔ Fabricate corrosion-resistant surface layers on refractories by either diffusion coating or selective sintering of secondary layers.
- ➔ Produce refractories having high-emissivity/designed surface coatings.



### PRIMARY

Oak Ridge National Laboratory  
Oak Ridge, TN

### PROJECT PARTNERS

Allied Mineral  
Columbus, OH

Emhart Glass  
Owensville, MO

Kyanite Mining Corporation  
Dillwyn, VA

University of Missouri-Rolla  
Rolla, MO

### FOR ADDITIONAL INFORMATION, PLEASE CONTACT

EERE Information Center  
Phone: (877) 337-3463  
Fax: (360) 236-2023  
eereic@ee.doe.gov

Visit our home page at  
<http://www.eere.energy.gov/industry/>

Office of Industrial Technologies  
Energy Efficiency  
And Renewable Energy  
U.S. Department of Energy  
Washington, DC 20585  
<http://www.oit.doe.gov>



January 2002